MEMOIRS OF THE GEOLOGICAL SURVEY.

ENGLAND AND WALES.

EXPLANATION OF SHEETS 357 AND 360.

THE GEOLOGY

OF THE

ISLES OF SCILLY.

BY

GEORGE BARROW, F.G.S.

WITH PETROLOGICAL CONTRIBUTIONS BY J. S. FLETT, M.A., D.Sc.

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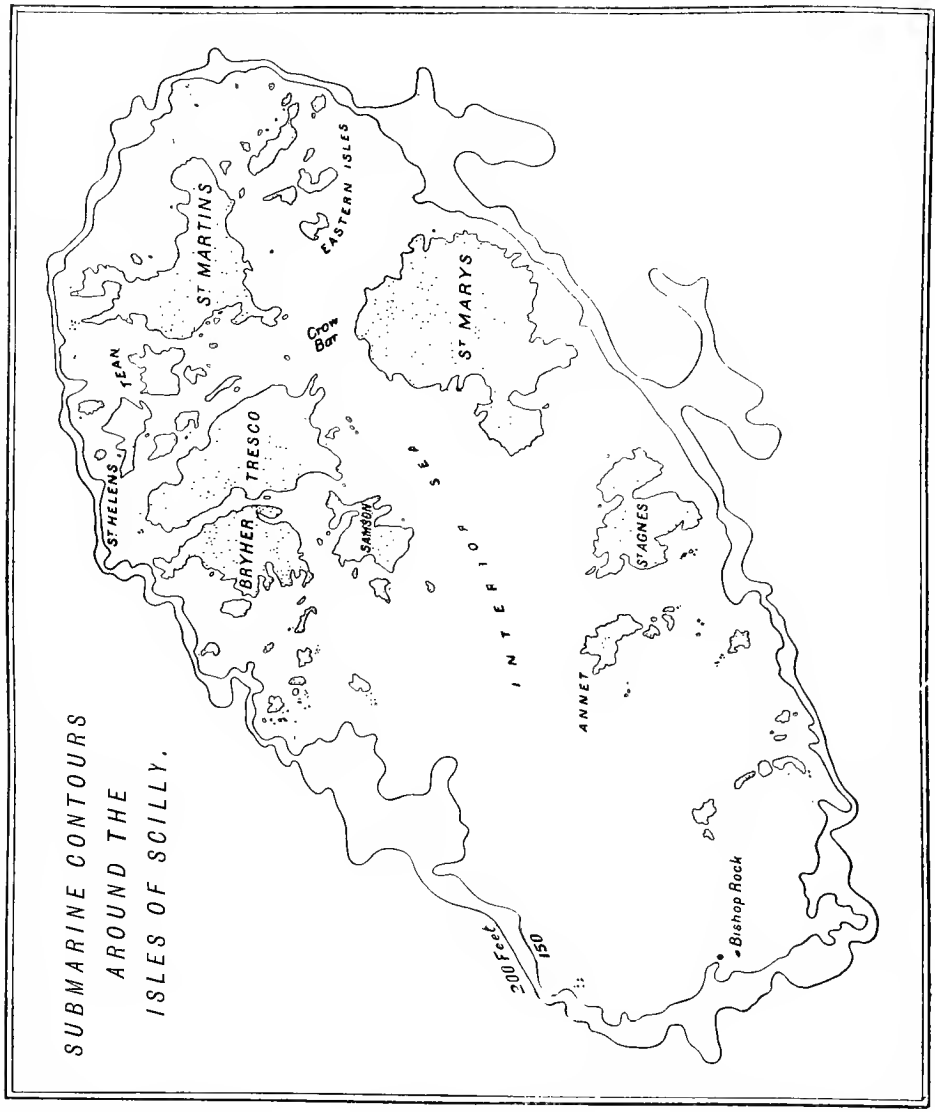
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CONTENTS.

ILLUSTRATIONS.

PREFACE.

This Memoir deals with the area represented by the colour-printed map of the Scilly Isles (Sheets 357 and 360). If we except certain scattered references in De la Beche's Report on the Geology of Cornwall, Devon and West Somerset, no description of these islands has been published by the Geological Survey. The most complete account hitherto available is contained in an important paper by Mr. Joseph Carne, to which reference is made in the following pages.

The detailed survey of the islands was entrusted to Mr. Barrow under the superintendence of Mr. Reid, and the work was carried out during the years 1903 and 1904. A few points of novelty have been brought to light, the most important being the recognition of greisen-bands in the granite, the discovery of a narrow strip of tourmalinized killas at the north end of White Island, the occurrence of ice-scratched stones and the presence of a somewhat doubtful outlier of Eocene gravel.

The petrographical descriptions of the roches are new and have been either contributed or revised by Dr. Flett. Mr. Reid has acted as general editor.

J. J. H. TEALL,
Director.

Geological Survey Offices,
28, *Jermyn Street.*

21st February, 1906.

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THE GEOLOGY

OF THE

ISLES OF SCILLY.

CHAPTER I.

INTRODUCTION.

THE Scilly Isles, which lie some thirty miles south-west of the Land's End, may be described as a series of flat-topped granite masses varying greatly in size and in the height to which they rise above the water. Altogether about 140 rocky islets and rocks have been counted, but only five are now inhabited. The largest, St. Marys, is, roughly, two miles long and 160 feet in height; and from this there is every gradation to a mere speck of rock visible at low-water. The larger islands are at the north-east end of the group, and the sea between them is quite shallow; but this enclosed, or, as it may be conveniently termed, "interior-sea" steadily deepens towards the small isolated rocks at the south-west end. A chart soon makes it clear that this deepening marks the position of a submerged inland valley, and that the present distribution of land and water results from the form of ground left by inland denudation, before the area subsided to its present level. If the submarine slopes be contoured to show the level of 200 feet below the sea (*see* Plate I.), then it seems further evident that the Islands result from the erosion and partial submergence of a continuous oval mass of granite similar to those of the mainland of Cornwall and Devon; as was long since suggested by De la Beche. *

* "Report on the Geology of Cornwall, Devon and West Somerset," 1839, pp. 9, 156, etc.

The encircling ring of altered stratified rocks has been cut down and is now submerged. In one place only has any of the altered Killas been so far met with; nevertheless, it must exist under water, and on the north-east end of the group it cannot be far from the present termination of the granite. At the southern end it is probably much farther out to sea.

The material formed by the denudation of the granite is an important component of some of the islands. This granite waste takes two forms, angular Head, and Blown Sand. The latter is by far the more important so far as bulk is concerned, and has often played the curious *rôle* of uniting separate granite masses to form one island or continuous land-surface; indeed, this phenomenon is one of the features of the Scilly Isles.

The climate of the Scilly Isles is essentially mild, being cooler in summer and warmer in winter than that of the adjacent mainland; even sub-tropical plants grow well in sheltered places, not so much from the warmth of the climate as from the absence of cold in winter. The finest examples of these exotic plants are seen in the gardens of Tresco Abbey.

The rainfall is only some 32 inches, much less than on the mainland of Cornwall; but a considerable amount of moisture is slowly deposited on the land at certain seasons owing to sea-fogs produced by the action of cold air-currents passing over the warm surface of the Gulf-stream.

The industries of the islands are chiefly horticulture and agriculture; much of the fishing being carried on by vessels coming from a distance and benefiting the islands to only a small extent. The most remunerative employment is that of growing early spring flowers and vegetables; and, later, tomatoes and grapes, both of which can be produced without the aid of artificial heat.

Agriculture (including dairy-farming), is carried on to a small extent, but, except in the case of fresh milk and possibly potatoes, the products are insufficient to supply the wants of the population in summer, though this is never large. The resident population in 1851 was 2,601; in 1901 it was 2,092.

Although the Islands are composed of granite, the rock is not quarried to any great extent and is never worked for exportation. The quarries that do occur are in comparatively soft material, and there are few accessible places where any rock sound enough to pay for working could be met with without first removing a considerable amount of more or less decomposed granite. The comparatively soft rock often forms a fairly good building stone, it undoubtedly contains much soluble silica. When the rock is placed in such a position that it can dry thoroughly, as in the walls of buildings, it hardens as the silica becomes insoluble, and is practically impervious to water.

The water supply of the Islands is obtained in two ways, from wells and directly from rain collected on the roofs and stored in

underground tanks. On the whole, the larger quantity is obtained in the latter manner. With the exception of a small runnel fed by a spring at Holy Vale, on St. Marys, there are no streams of any kind in the islands.* One strange point about the wells is that a fair number are comparatively close to the sea and are sunk a little below sea-level. The water in these rises and falls to some extent with the tide, yet the water itself seems quite fresh. The sea simply keeps in the fresh water that is working through the granite towards sea-level. The quantity drawn at any one time from such wells is of course comparatively small, or the salt water would find its way in. On the small island of St. Helens, near the old Quarantine House, there is an ancient well, the bottom of which is some depth below sea-level; and it is confidently reported that the sea-water does enter in this case, but loses its salt in so doing!

The earliest geological descriptions of the Isles, beyond brief notes by R. Heath, were published in the middle of the eighteenth century by the celebrated Cornish naturalist, William Borlase, whose accounts, however, are mainly archæological. Then, after an interval of sixty years, the Isles were again briefly alluded to by Majendie. In 1839 De la Beche's "Report" contained a few additional particulars; but it was not till Joseph Carne wrote, in 1850, that the geology of the Isles was systematically described. Carne dealt with the character, structure, and jointing of the granite, with its disintegration, and with the products of its destruction, thus laying the foundations of our knowledge on a firm base.

The rocks represented in the Scilly Isles are as follows:—

Recent	Blown Sand. Alluvium.
Pleistocene	Upper Head. Iron-cement and Glacial-deposit. Lower or Main Head. Old Beach.
Eocene?	Gravel of St. Martins.
Palæozoic	Altered Killas.
Igneous Rocks	Elvan or Quartz-porphyry. Inner-granite (finer). Outer-granite (coarser).

* For particulars of some of the old wells and springs *see* R. Heath, "A Natural and Historical Account of the Islands of Scilly," 1750, pp. 77–81.

CHAPTER II.

GRANITE AND ASSOCIATED ROCKS.

In the Scilly Isles there are two common types of granite, one coarse-grained with porphyritic crystals of felspar, the other finer and non-porphyritic. The coarse-grained granite is the dominant constituent of the islands, the finer rock being confined to the north and west sides of St. Marys, the south part of Tresco and Bryher, Samson, and the north-west side of Annet. It will be seen that the fine-grained granite occupies the central part of the Scilly area and is everywhere surrounded by the coarser; probably between the above-named islands a considerable extent of the fine rock is covered by the sea. As a rule there is no sharp boundary between the two varieties of granite, but a gradual passage from the one type to the other. This is well shown on the west side of the north end of St. Marys where, after repeated examination of the ground, it was found impossible to fix any definite line of demarcation, and consequently that shown on the map is more or less arbitrary. In some places, however, the contrast between the two types is strikingly evident, as on the coast to the north-east of Hugh Town, and near New Grimsby in Tresco, but this is exceptional. The fine-grained granite may pass into a coarser rock, while the porphyritic coarse-grained granite, which retains its porphyritic structure over all the southern islands, almost loses this character towards the north end of St. Martins and Tresco, and often assumes a slightly foliated aspect.

Veins of fine granite are not unfrequently to be observed intersecting the coarser porphyritic variety; these will be described in a subsequent part of this chapter, but as they resemble very closely the fine granite of the interior mass, they render it probable that as a whole this is intrusive into the coarser rock.*

Both granites contain muscovite and biotite, orthoclase and quartz. Tourmaline is more or less sporadic in its distribution, being abundant in some places while elsewhere it is scarce. The porphyritic felspars in the coarse granite have an average length of an inch or more, but do not usually show very perfect crystalline faces. They have generally a marked parallel arrangement which gives the rock a deceptive appearance of bedding. Occasionally all the long axes of the crystals have the same orientation; this is best exemplified in the eastern islands, especially the Great Ganilly. This structure is apparently due to fluxion movements during the slow process of injection, and very frequently the lines of fluxion are undulating, so that the tabular felspars become vertical for a space and then resume their nearly horizontal disposition. Most of the large felspars show Carlsbad twinning clearly to the naked eye. The felspar is nearly always white and opaque, though sometimes yellow or brownish from staining by iron-oxides. Often the crystals, especially the phenocrysts, contain crystals of mica, and these may be arranged in zones parallel to their surfaces. Plagioclase is not

* *See* De la Beche, "Report on the Geology of Cornwall, &c.," p. 161.

abundant and in the typical coarse granite is not easily recognised in the hand specimens, but when the rock is fairly fresh the oligoclase is often more decomposed than the orthoclase and has a yellow or reddish-yellow colour. The quartz varies considerably in amount and is less abundant than the felspar.

A section of the typical coarse granite from Peninnis Head on the south side of St. Marys consists essentially of orthoclase, plagioclase, quartz, muscovite and biotite. The orthoclase is somewhat turbid with decomposition products, but in polarised light shows Carlsbad twinning and almost invariably also a perthitic structure, as veinlets and minute irregular patches of a plagioclase felspar are scattered abundantly through it. It contains also scales of muscovite and biotite, idiomorphic plagioclase crystals and rounded grains of quartz. Myrmekitic or vermicular micropegmatite often borders the orthoclase and sometimes also the plagioclase. The idiomorphic crystals of plagioclase are frequently zonal and are often much decomposed near their centres. They belong to oligoclase and albite-oligoclase, as can be easily proved by their refractive indices when they contain quartz enclosures. The behaviour of these crystals in cleavage flakes shows that they are not all of the same composition, as some of them are normal oligoclase while others contain more of the albite molecule. The quartz is in every respect that which is typical of granites and occurs as an interstitial material between the felspars, and to a much less extent as rounded or irregular enclosures in the perthitic orthoclase. It occasionally shows effects of crushing, by polarising as a mosaic of interlocking grains which have slightly different positions of extinction. Fluid enclosures are very numerous and give it a dusky aspect. They lie in rude bands or strings and contain a mobile bubble and often also a small cube or rod-shaped microlith.

The biotite and muscovite tend to occur in clusters and are frequently in parallel growth, the muscovite being then the later of the two minerals. The biotite is very strongly pleochroic with colours ranging from pale brownish yellow to dark brown with a reddish tinge. Dark pleochroic halos are very common, and the edges of the crystals have sometimes a deeper colour than the centres. Both micas colour the blowpipe flame a faint red, and on spectroscopic examination yield a strong lithia reaction; the biotite is consequently a lithionite. Its axial angle is always small; the pale mica is a lithia-bearing muscovite. Occasionally the crystals show idiomorphic six-sided outlines, but generally they have irregular borders, which in the case of the muscovite are often frayed out or feathery. Apatite occurs in rather large grains; zircon is frequent and small dark hairs of rutile may be present in the quartz.

Taken as a whole the coarse Scilly granites show little tourmaline whether in the hand specimens or under the microscope, but in some places patches have been met with which are rich in schorl. The true relations of these to the main mass are not always clear, but they may be of the nature of segregations or perhaps of intrusive origin. A good example of this modification occurs at the extreme south end of St. Agnes, and a few other instances have also been met with.

The granite from the above-mentioned locality carries phenocrysts of orthoclase one and a half inches in length, Carlsbad twinned, lying in a matrix of orthoclase, tourmaline, muscovite and quartz. The black prisms of schorl and pearly crystals of white mica are very obvious in the hand specimen, the mica being often more than a quarter of an inch in diameter. The felspar is white or slightly yellow, and quartz is comparatively scarce. Under the microscope the principal component is orthoclase, often rather coarsely perthitic. Clear, unweathered microcline appears also in a few places, grown upon the surface of the microperthite and probably filling microlitic cavities.

The small amount of quartz visible in the section is mostly scattered through the felspar where it occurs as rounded or angular enclosures. The muscovite is partly idiomorphic, partly in clusters of irregular flakes. It contains small crystals of zircon, surrounded by pale yellow pleochroic halos, but is elsewhere colourless. Though yielding a strong spectroscopic reaction for lithia it is in other respects a normal muscovite with an axial angle about 70 degrees. The tourmaline occurs in grains which have often little trace of crystalline outline, mostly mixed with muscovite and quartz in the interspaces between the felspars. Their colour is very varied, being dark brown, yellow, green and blue, and they are often zonal. Some crystals have pale blue centres passing into yellow and brown at the margins. Others are yellow in the interior but have a dark brown border with sometimes another thin blue zone external to this. Not unfrequently a growth of small acicular prisms surrounds a large compact crystal. Zircon and apatite are both common, the latter in large grains. The complete absence of biotite indicates that tourmaline under some conditions replaces it.

As already stated there is in most cases a passage from the coarser to the finer granite. A good specimen of the intermediate type was obtained from the bottom of a well sunk on the north side of St. Marys by the edge of the road under the old castle.

It is a medium grained or rather coarse granite without conspicuous orthoclase phenocrysts, and showing both muscovite and biotite in the hand specimen. In the microscopic section the features which characterise the groundmass of the Peninnis Head rock (*vide supra*) are all repeated, but tourmaline occurs in large irregular brownish crystals mostly embedded in quartz, and spotted with green pleochroic halos around small indeterminable enclosures. The biotite is a dark reddish-brown lithia-mica with intense pleochroic halos and very marked pleochroism. It is frequently surrounded by muscovite in parallel growth. Plagioclase, usually turbid in the centre, but transparent at the margins, where it has the optical properties of albite (oligoclase-albite) is rather abundant. The orthoclase is very frequently perthitic, but microcline is absent. In the tourmaline and sometimes in the muscovite and quartz large numbers of little acicular microlites are found. Their nature could not be certainly established.

Typical fine-grained Scilly granite is well seen at the crag at the landing place at the south end of Tresco. The average diameter of its crystals of quartz and felspar is about one-tenth of an inch. Muscovite and biotite are both visible in it, but tourmaline is scarce and only one small crystal of it is present in the microscopic slide. Another specimen from the coast near Porthloo, east of Hugh Town, is still finer grained and contains abundant tourmaline and but little biotite. The finest material occurs at the same locality, on the boundary of the inner granite as shown on the map. Its felspars are white, yellow and pink, and many small prisms of dark schorl are scattered through the rock.

There is no essential difference in microscopic character between the finer non-porphyritic granites and the common coarse-grained types. They contain more tourmaline, which appears to be an original ingredient and takes the place of biotite, as any increase of the former is attended by a diminution in the quantity of the latter.

The tourmaline is brown or greenish-brown, rarely blue, and though sometimes in well-formed prisms is usually irregular in outline, and often penetrated by, or in graphic intergrowth with quartz. The biotite and muscovite

are similar to those of the other granites, the biotite having always the same red-brown colour, intense pleochroism and rounded pleochroic halos. Orthoclase, very commonly perthitic, oligoclase and oligoclase-albite are always present, and their relative proportion varies only slightly. Apatite is common in large grains and zircon is never wanting, but iron oxides are very scarce. Topaz has not been observed in any of these rocks.

Inclusions and Intrusions in the Granite.

The best locality for obtaining a clue to the minor details of the granite is the shore of Great Ganilly, one of the eastern isles. Here four separate phenomena may be noted. (1) The occurrence of a number of very small oval patches, the origin of which cannot be determined satisfactorily by field evidence alone. (2) A great number of anastomosing fine granite veins, clearly intrusive. (3) Fairly numerous small, rather lenticular pegmatitic or coarse granite patches and veins, clearly intrusive, for they cut the granite veins above mentioned. (4) A number of cracks or fissures, trending east-north-east, often filled with greisen and schorl rock, along the edges of which the granite has been more or less altered. These lines cut 2 and 3.

(1) The little oval patches are always fine-grained and somewhat greyer than the normal rock, and even in a hand specimen they can be seen to contain a greater proportion of biotite, which occurs as small crystals. So far as their mode of occurrence goes they might be the taper ends of small veins, but they have a distinctly different composition and contain more biotite and plagioclase and less muscovite than the normal granite. They are distinctly less acid and slightly older than the rock which surrounds them and the microscopic section prepared from one of these inclusions was found to contain no tourmaline. The junctions with the coarser rock seem too sharply defined for these to be claimed as mere segregations. Similar oval patches have been met with on the northern and western parts of St. Martins, Tresco and Tean, but they are less common than on the Great Ganilly. On St. Marys and St. Agnes they are distinctly rare, and none were seen on the south side of either of these two islands.

(2) The anastomosing narrow veins of fine granite are specially abundant along the east side of Great Ganilly. In the majority of cases there seems to be a master-vein from which the smaller ones proceed and at this particular locality the former generally has a north-north-west trend, though this direction is not strictly maintained in the other islands. The junction of the veins with the coarser granite, though fairly clear, can hardly be called sharp; they never have fine-grained margins like those of the elvans, and however small, they are always granitic in texture. In many cases the thicker veins have a faintly pinkish tinge due to the dissemination of small crystals of greatly decomposed oligoclase.

A specimen (4287)* from one of the master-veins on the east side of the island shows this well. In it the orthoclase crystals are fairly large, while the plagioclase occurs in much smaller idiomorphic crystals, the centres of which are greatly decomposed, while the margins are almost glass-clear. Brown and white mica are both fairly abundant and schorl is also present, though in less quantity than in some of the smaller veins. It is yellow and brown, with rounded green pleochroic halos. On the crest of the south-west end of the island, one of these veins swells out locally to a breadth of at least 50 feet, and afterwards narrows, clearly throwing out processes as it does so. Along certain portions of the margins of this broader vein patches rich in schorl occur, but no clear evidence of any modificaton of the adjacent granite was observed.

These veins are common also at the north-west end of St. Martins, on Tean and to a smaller extent on Tresco. A similar material is extraordinarily abundant over the whole southern portion of the west side of Bryher, and it occurs in a rather unusual way. Ramifying sills are especially common, best seen on the projecting headland at the extreme south-west end of the Island. Further north, patches of all sizes and strange shapes are met with, which from their composition must be part of the same material, yet in many instances they have the aspect of an original outer edge of an intrusion. The probable explanation is that a considerable mass of the finer granite lies close below the present surface; and this view is strengthened by the strong resemblance of this ramifying material to the first outcrop of the finer granite, near Porthloo on St. Marys, already referred to, and also by the fact that similar granite veins are rare in the inner granite core, as must obviously be the case if they are essentially the same material.

A typical example of the granite veins in the northern part of the islands, taken from the north-west end of St. Martins (4286) is composed of orthoclase, a little plagioclase and small grains of quartz, set in a rather confused matrix of quartz, felspar, white mica, and schorl. The latter occurs in small idiomorphic prisms, highly zonal with yellow, brown, green, and blue colours, and with green or bluish pleochroic halos. No brown mica is present, and this mineral seems always rare or absent in the finer granite veins. In the specially massive portions of the granite, these veins are rare, and the few that do occur are usually of extremely small dimensions. An example of these occurs on the top of the cliffs to the east of Old Town, St. Marys. It is a pale-grey to white fine granite, composed of felspar, quartz, a little white mica, and schorl in numerous small acicular crystals; thus closely resembling the specimen from St. Martins in composition.

(3) As already stated small veins containing felspar, quartz, and schorl, often in large crystals, are fairly common on the east side of Great Ganilly; they are obviously a form of pegmatite veins, though they have usually a straight course. In a few cases they seem to have affected the adjacent granite to a small extent, though there is usually no sharp junction between the two. That they are intrusive is clear, for they cut the fine granite veins. These pegmatites occur over the whole of the Scilly Isles, but are more common on the north and rare to the south.

* These numbers refer to the Microscopic slides in the Survey collection.

(4) In Great Ganilly, the largest of the eastern isles, all the rocks previously mentioned are traversed by a series of nearly vertical cracks along which the granite is modified or altered to a varying extent. These cracks may be conveniently called greisen-lines, and by their abundance and the phenomena associated with them they closely ally the granite of the Scilly Isles to the large masses of the south-west of England, for in no other intrusions in Great Britain do these greisen-lines form such a conspicuous feature. They tend often to occur in groups, and in this case the alteration on their margin is most marked. They have over most of the islands a definite trend, approximately east-north-east and west-south-west, though each individual crack may have a slight local curvature and the members of a group often anastomose. The central crack may at times contain nothing between the bounding walls of altered granite or greisen. More commonly there is a small thickness of quartz and schorl, which, when finely commingled, assumes the bluish aspect of the "peach" of the mainland granites, and of the tin veins. In the Scilly Isles this infilling peach rarely attains the breadth so often met with in Cornwall; a vein more than six inches wide is quite exceptional, and the majority of the veins do not exceed an inch, though several of these may occur comparatively close together. These greisen-lines are most numerous and can be best studied on the eastern isles, especially Great Ganilly. They are easily eroded, and the little narrow depressions to which they give rise can be traced across the island. A good example of an anastomosing group occurs in the hollow, covered at high water, between the north end of Great Ganilly and the little detached islet of Morrow. The belt of granite affected by this group is rather more than four feet wide, but the extent of alteration varies not only in the belt as a whole, but also along the edge of each separate crack. In one instance (4288) the granite is completely altered to a depth of six inches and is a true greisen or quartz-muscovite rock. The white mica is very abundant, and by the unaided eye only this mineral and quartz can be seen, the biotite and tourmaline being very inconspicuous, while the felspar has entirely disappeared.

In the microscopic section the principal constituent is quartz which contains many fluid cavities mostly of irregular form, but a few are negative crystals. White mica in clustered tablets is almost equally common. Much of it is perfectly idiomorphic; it is for the most part colourless, but is occasionally slightly green, and shows small, pale greenish-yellow pleochroic halos round enclosed zircons. Optically it is muscovite with axial angle of from 60° to 70° (2E), but it colours the blow-pipe flame very faintly red, and with a pocket spectroscope yields a strong lithium line. A curious variety of biotite which differs entirely from that of the normal granite is also present. Its colour is brownish-green with marked pleochroism; it forms hexagonal plates or irregular scales which are sometimes grouped in radiate clusters. Undoubtedly it is of new formation, and occasionally can be seen to decompose into dark-green chlorite. The slide contains also a small quantity of tourmaline, brown or blue in colour and usually zonal. Its crystals are irregular and are mixed with quartz. Pale blue needles, which become almost colourless

when the nicol is rotated, may also be seen lying in the quartz and muscovite. Zircon is abundant; apatite occurs in large rounded grains, but topaz was not found either in the section or in the crushed powder of the rock. A very few grains of iron oxide may also be detected.

Along the edge of another crack of the same group, the alteration rarely extends to a depth of more than two inches and the outline of the felspar remains distinct right up to the edge, but the biotite is more difficult to recognise. Much schorl is present, which on being powdered up was mostly brown. No metallic ore was seen. The infilling material varies from quartz with easily recognised schorl needles to compact "peach."

In the more isolated lines the crack is generally filled with a similar admixture of quartz and schorl; in some cases quartz alone occurs, in others quartz and schorl mixed together, but each easily recognisable, but the most common is a thin seam of fine "peach." The cheek of the crack is often merely changed to a brown colour, the original minerals remaining recognisable except the biotite, and even of this the outline can generally be traced. Thus though the phenomenon of greisen-lines is just as characteristic as in the mainland, the thickness of the quartz-schorl veinstone is usually far less and the true greisen alteration is not so common.

Similar groups may be noted in the other islands, though single lines are far more frequent. A good example of the latter can be seen at the steps of the lifeboat-house, on St. Marys; while a typical anastomosing group occurs on the north end of the west side of the same island.

Small veinlets of typical peach and schorl-rock are abundant at the north end of Tresco, about Cromwell's Castle; and it would appear that some of these must have contained a little tin, for there are many narrow oblong pits on the ground above, clearly, from their trend, dug along these veins. Borlase mentions that in this neighbourhood "we found a row of shallow Tin-pits, none appearing to be more than four fathom deep, most of them no deeper than what the Tinners call *Costean* Shafts, which are only six or eight feet perpendicular. . . . This course of Tin bears East and West nearly, as our Loads, or Tin Veins, do in *Cornwall*. These are the only Tin Pits which we saw, or are anywhere to be seen, as we were informed, in these Islands."* The infilling material and its bounding walls have been dug away and the base of the hollows is covered with loose earth, so that the exact nature of the original material cannot now be seen. A little to the south of these hollows on the curious flat-topped tableland small fragments of peach are extremely abundant and there is good reason to suspect that the presence of this material, as well as the occurrence of a small quantity of metallic ore in this locality is in some way connected with the outer margin of the granite; in fact we may readily believe that the junction of the granite with the altered killas is comparatively close to the extreme northern end of Tresco.

On the south side of St. Marys and of St. Agnes, where the granite is exceptionally solid, none of these nearly vertical greisen

* "Observations on the Ancient and Present State of the Islands of Scilly," 1756, pp. 45, 72.

lines have been noted. But they are apparently represented by curious nearly horizontal cracks filled with a thin film of quartz-schorl rock. The alteration along these low-hade planes is usually quite small and no true greisen has been observed. Excellent examples occur on the coast about a quarter of a mile south-east of Old Town, St. Marys, where they are numerous and can be traced for considerable distances in an easterly direction. A. Majendie, writing about the year 1814, mentioned that "A small quantity of tin was raised in St. Marys about twenty years ago."*

On the south side of St. Agnes one of these planes is coated with schorl needles uniformly orientated over rather large surfaces. There is a good deal of schorl in the adjacent granite here, but the presence of this mineral is not accompanied by any considerable development of additional white mica. Unfortunately the rock surface is so obscured by huge boulders that it is difficult to be sure that this is a modification of the normal granite and not a thin sheet-like local intrusion. In some places the undoubted normal granite is in contact with this sheet of schorl needles, but the amount of alteration is still singularly small though the granite itself is at times slightly foliated to a depth of several inches. In this vicinity some of these low-hade cracks are filled with compact fine-grained dark-blue peach.

A specimen of this was sliced and proved to consist mainly of acicular or granular blue tourmaline and quartz. The rock is a breccia in which angular fragments of quartz, pieces of felted blue tourmaline and of a mixture of quartz and tourmaline are cemented together by a much finer grained matrix of the same composition. A vein of quartz, blue tourmaline, and white mica traverses the centre of the specimen, and evidently represents the latest infilling material. Many very small grains of a brown mineral, which has the appearance of cassiterite, are scattered through the section. Their average diameter is about one-five-hundredth of an inch. A sample of this rock, crushed and tested by Dr. W. Pollard, proved to contain tin.

North and South Cracks.

Clearly later than the lines of greisen-action are a series of cracks or fissure lines trending slightly west of north. They are best seen on the northern shores of the islands where the Atlantic waves are better able to erode the crushed granite on their margins. So far as is known, no intrusions occur along these lines and there is no sign of greisen action along them, from which it may be fairly inferred that they are the newest movement lines affecting the granite. They have an important bearing on the configuration of the islands, and on the production of the water-ways into the interior sea. They have an additional importance, however, as, like the greisen-lines they also occur on the mainland and still further serve to link the granite of the Scilly Islands with those of Cornwall. In the latter area, these lines, where they cut the killas, frequently contain veins of lead or iron ore. Unfortunately no such ore has been met with in the granite of the Scilly Islands. The features due to these cracks are illustrated in Plates II. and VI.

* *Trans. Royal Geol. Soc. Cornwall*, vol. i., 1818, p. 31.

Weathering of the Granite.

Attention has been directed by most writers on the Scilly Islands to the effects of weathering on the granite.

De la Beche, who gave figures of some of the weathered rocks, thus refers to them :—*

"The rock known as the Giant's Punch Bowl, in St. Agnes, one of the Scilly Islands, will probably exhibit the irregular decomposition of the two blocks of granite piled upon each other as well as any we could select. The upper block has externally a somewhat rounded character, such as has been supposed to arise from the decomposition of an original and concretional structure of the component parts, while the lower exhibits a form as irregular as can be well desired, being decomposed in a notch on one side, and projecting out in an angular manner on the other. The highest block is decomposed on the upper surface, so that one of those cavities, commonly termed *rock basins*, and supposed formerly to have been the work of the Druids, is produced, extending even through the upper block to the division between it and the lower. There seems little reason to doubt, however isolated these blocks may now be, that they are the remaining portions of granite, similar to that on which they stand, that have resisted decomposition better than those which surrounded them, the latter having, by degrees, been disintegrated and removed."

"Rock basins are so common in all the chief granite districts, that it is difficult to find any number of tors or carns on which some traces of the kind of decomposition thus termed may not be found. The largest cavities thus formed in any number near each other which we have seen are those represented in the Kettle and Pans, on St. Marys, Scilly.† Though we may regard these basins as natural productions, due to atmospheric influences, and therefore not the work of the Druids; it does not follow that the latter may not have made use of a few which may have been properly situated for their purposes, even giving a more artificial form to some, should they have required similar basins at all."

"As we have often observed these fragments in motion during high winds, both when the basins were dry, or a small quantity of water in them, we are inclined to believe that this may be the case."

Elvan or Quartz Porphyry.

Only two occurrences of elvan have been noted in the Scilly Isles, and both are on St. Marys. Indeed it is probable that they belong to one and the same dyke though the outcrops are not continuous at

* "Report on the Geology of Cornwall, etc.," pp. 451, 452 : *see also* Carne, *Trans. Royal Geol. Soc. Cornwall*, vol. vii., p. 143 ; and F. F. Statham, *Geologist*, vol. ii., p. 26. (1859.)

† *See* Plates III. and IV. Dr. McCulloch has suggested that the friction of the quartz and felspar fragments, not unfrequently found in rock basins, may have contributed to deepen them.

the surface.* The first is seen on the coast at Porthloo, a little north-east of Hugh Town.

It is a grey or pinkish-grey porphyritic rock with large phenocrysts of white or pink felspar (some of which are an inch in length) and smaller grains of quartz. Dark green pinite pseudomorphs, about one-eighth of an inch in diameter, can be detected in many specimens, and are locally abundant. The matrix is fine-grained and grey or reddish in colour. It is most abundant near the margin of the dyke, where it may show a fluxion banding when weathered. The large felspars are highly idiomorphic; they are somewhat turbid with decomposition products, but most are perthitic orthoclase, a lesser number being acid oligoclase. They frequently enclose idiomorphic crystals of biotite and rounded blebs of quartz, and the orthoclase felspar may surround the plagioclase. The quartz is in most cases slightly rounded by corrosion and contains enclosures of the ground-mass, small irregular fluid cavities (mostly negative crystals) and occasional scales of biotite. The brown mica is idiomorphic, and is fresh only when surrounded by quartz or felspar, elsewhere it is entirely altered into chlorite, rutile, etc. It is dark-brown with many pleochroic halos. The ground-mass is a fine micro-granitic aggregate of quartz, orthoclase, and scaly muscovite.

The pinite is seen in the hand specimen to form six-sided prisms not much longer than broad and terminated by flat ends. Under the microscope it consists of fine tufted sub-radiate muscovite, mixed with a considerable amount of pale green feebly pleochroic chlorite. Apatite, zircon, and iron oxides are the other accessory minerals. Towards the margin of the dyke the phenocrysts become smaller and less numerous and the matrix finer grained and more abundant. A micro-poikilitic structure replaces the micro-granitic structure of the ground-mass, and there are narrow graphic halos round the quartz phenocrysts. These latter are small, and have suffered little corrosion, as they mostly retain their sharp crystalline outlines. Minute scales of secondary muscovite are very abundant, and there is often also much diffused chlorite or hæmatite. Small pinite pseudomorphs (consisting of sub-radiate chlorite and muscovite) occur also in the fine-grained margin of the dykes.

Altered Killas.

Only one small outcrop of Killas has been noted in the whole of the Scilly Isles, and this occurs at the north end of White Island, to the north-west of St. Martins. It consists of a narrow dyke-like patch, some 200 yards in length, but rarely exceeding three feet in breadth. It distinctly tapers downwards, indeed, at the west end of the granite spur, the patch of Killas comes to an apex or point, and one can clearly see the granite underneath it. This mode of occurrence at once suggests that it represents a local downward extension of the original roof of the granite, and this idea is strengthened by the fact that the latter becomes distinctly finer in grain as the Killas is approached. As would be expected from its position, this patch of sedimentary material is greatly altered, it is thoroughly schistose and much tourmalinised. From the minute puckered folding still visible on the weathered surface it was originally a finely banded shale. The microscopic sections show that the

* *See* De la Beche, "Report on the Geology of Cornwall, etc.," p. 174. The occurrence of "porphyry" was noticed by Majendie.

rock is a thoroughly crystalline schist mainly composed of quartz, white mica and abundant schorl, the latter occurring either as fairly large crystals, or aggregated groups of small ones. The tourmaline is usually blue at the centres of the crystals and brown at the exterior. A little biotite is also present and grains of colourless apatite. This rock shows essentially the greisen type of alteration and a similar alteration of the Killas may sometimes be found in rocks taken close to the margin of the granites in Cornwall. At the junction with this altered Killas the granite is distinctly foliated, and here and there shows a certain amount of greisen alteration as well.

CHAPTER III.

DRIFT.

With the exception of a small patch of reconstructed gravel, perhaps of Eocene date, no trace of secondary or tertiary deposits has yet been discovered on Scilly, and little can be said about the geological history of the Isles between Carboniferous and Pleistocene times.

An outlier of subangular gravel, largely composed of Chalk-flints and Greensand-chert, which caps the highest part of St. Martins, is so like the Eocene river-gravels of Devon and Dorset, and so closely resembles the reconstructed Eocene gravels of Mount's Bay, that in all probability it also is a remnant of an old valley-gravel of Eocene date. If such is the case the flat-topped Isles (*see* Plate II.) must be a last relic of an old table-land over which Eocene rivers, probably radiating from Dartmoor, flowed outwards, across what is now part of the Atlantic. An examination of the gravel shows that much of the Cretaceous material consists of the peculiar flint and chert so abundant at Haldon, on the east side of Dartmoor.

If we may judge by what happened in the Land's End district, the Isles must have been entirely submerged in Pliocene times, for on the mainland a wide shelf or plane of marine denudation of Pliocene date slopes gradually upward to about 430 feet above the sea, above which level the hills begin. No trace of Pliocene deposits, however, has been found in Scilly; though this is not surprising, for the whole of West Cornwall only shows three small outliers, but one of which, that of St. Erth, is fossiliferous.

The Raised Beach.

In many places along the inner coast-line of the Scilly Isles, clear traces of terrace-features may be observed; but, on examining the material of which these are formed, it is found to be the well-known Head, which is certainly not of marine origin, and as the terraces cannot be of fresh-water origin, the aspect of the ground is at first difficult to account for. Further, in a good number of cases, small patches of firmly cemented conglomerate, formed exclusively of small granite boulders, were met with, and, owing to the sloping surface on which it often rests, the true nature of this deposit and its geological significance are not at first sight easily grasped. The sections seen on the Cornish coast, however, at once make clear the meaning of the patches of conglomerate and terrace features. The conglomerate is the remnant of an old beach, only very small patches of which are now left; but while the beach deposit has, in the main, been eroded away, the old platform on which it rested has been left in many places, with the result that the Head which

practically occupies the old position of the beach-material has a terrace-like contour imparted to it. As already stated, the old beach is made up exclusively of small boulders of granite and their size is, on the whole, singularly uniform, roughly some three or four inches in diameter. The beach is always firmly cemented together and is, in fact, a conglomerate. The largest patches occur on Annet; where they rest on a somewhat uneven surface, and possibly may be more continuous than the exposures on the shore suggest. The beach must clearly have once extended over all but the little rising patch of ground at the north end of the island, but the surface is somewhat obscured by fine sandy material that has been curiously honeycombed by the puffins in order to build their nests.

Very small patches of similar conglomerate occur at the north end of the adjacent island. Its true position is accurately fixed on White Island* where it rests on the bare granite and underlies the main Head, a glacial deposit in turn reposing on the latter. This section brings out, in the clearest manner, the sloping nature of the surface on which the beach rested at its highest point and it is equally clear that, as in the case of Annet, the old platform must extend over a considerable portion of White Island, a good deal of the conglomerate being possibly preserved as well, but the fact is again obscured by the newer deposits here consisting of Head and blown sand. A minute patch of the old beach still exists at the head of a little recess in the north-west coast of Bryher (Hell Bay). It here lies well above high water mark and is again capped by Head, with a thin skin of glacial-deposit above. This section shows exceptionally well the sharp slope of the upper portion of the old platform, and is specially worth recording as it is being rapidly denuded away.

The small size and obscure nature of the outcrops make this deposit at first very difficult to recognise and, no doubt, several minute patches have been overlooked, for much of the Islands had been surveyed before the clear outcrops mentioned above had been seen. The most accessible of these small remnants occurs at the foot of the low cliff north-east of Hugh Town, St. Marys, just before reaching Porthloo. The Head here forms a low cliff, and beneath the former is a very small but unmistakable patch of the typical conglomerate. This outcrop is specially valuable, as after the nature of the material has once been realised, there is no difficulty in recognising similar minute patches in other localities. Another point of interest in the exposure at Porthloo is the occurrence in the overlying Head of a few isolated rounded boulders of beach material, pointed out by my colleague, Mr. Reid. They could only have got into this position from a slightly higher level originally, and they could not have been at that higher level unless the beach had a rather steep upward slope. These little boulders

* *See* p. 22, where this important section is fully described.

serve, moreover, to show that the material of the Head in which they lie must have travelled seaward or away from the steep granite slope behind it for a good many yards.

The terraced aspect of the upper surface of the Head at this locality is now clearly seen to be due to its reposing on the old platform; and as similar terraced-looking patches of Head are extremely common along the shores of the inland sea, the old beach must have been at one time continuous along the whole length of these shores, except where the granite forms projecting headlands; indeed, in all probability, it formed a more or less continuous fringe along the outer coast-line too, but recent earth movements having brought it within reach of the powerful Atlantic waves, all but the merest trace of it has been destroyed.

Standing at the head of the pier at Hugh Town, on a calm day when the tide is out, remnants of the old platform may be recognised on many of the small patches of bare rock projecting above water. These rocks have what may be conveniently termed a head and shoulders; the shoulders are the old platform at exactly the same level on each side of the small central projecting portion or head. All the shoulders, on all the small rocks, are at about the same height, and it is now seen that, though there was a sharp slope to the landward edge of the beach it was at a singularly uniform level at a short distance seaward from the old cliff. Thus in the Scilly Isles, as on the Cornish coast, there is an old Beach underlying the Head; but far more of it is preserved in the mainland, only very small patches being now left on the islands.

A special significance, however, attaches to this old Beach of the Scilly Isles, for not only does the main Head overlie it, but also the glacial deposit described on p. 21. The occurrence of the latter in this position identifies it at once with the old beaches described in South Wales and along the south coast of Ireland.* It thus serves to link these old beaches with that of the mainland of Cornwall. As the main platform now occurs only a few feet above low water mark, it becomes clear that considerable upward and downward movements have taken place in this part of England in quite recent geological times; but the evidence for this can be more conveniently discussed after describing the blown sand and the curious reason for the existence of such a large quantity of it on these small islands.

Head.

A conspicuous feature at the foot of the inner cliffs of the Scilly Isles is the accumulation of angular or subangular fragments of granite in an advanced stage of decomposition. To this the term Head has been applied. The same material also occurs at the foot

*See W. B. Wright and H. B. Muff, "On a Pre-glacial Raised Beach on the south coast of Ireland." *Proc. Royal Dublin Soc.*, vol. vi. (N.S., Part II., No. 25.)

of the outer cliffs, or those facing the Atlantic, but only in very small quantity and in receding hollows or small bays. There was obviously, at one time as much Head in the outer cliff foot as on the inner, but so much greater is the force of the waves of the open Atlantic that almost all of it has now been removed. It becomes at once obvious that this material is now being removed far faster than it accumulates, and that conditions must formerly have prevailed which both favoured its formation and possibly protected it from denudation.

The Head usually shows little trace of bedding, and a feature of the larger granite fragments is their curious form, one face being rather flat, the other rounded. Its mode of formation and the method by which it reaches its present position are not altogether clear, but an examination of the shores of these Islands shows that it often grows from both the top and base at the same time. In many of the lower cliffs, where there is a small shelf of rock, just about or above high water mark, the mode of growth can be seen to be as follows. A master crack proceeds vertically downwards into the granite and from this minor curving cracks proceed. In extreme cases, the two cracks meet and a block of the granite is detached from the parent rock altogether ; but in many instances complete severance from the main mass has not taken place, and then the exact process of formation of the curious shaped fragments, flat on one face (that of the vertical crack) and curved on the other can be clearly made out. It follows from these facts that the exact base of the Head is difficult to define.

It clearly grows upwards from the top, owing to the rolling or working down from the adjacent steep bank or old cliff of fragments detached by the process just described, and as might be expected, the coarsest material always occurs close to the foot of the steeper slopes.

The Head, in special localities, can be divided into two parts, an upper and a lower. This fact is well shown in the bay at the west foot of the Beacon Hill of St. Martins, where the two portions are separated by a curious glacial deposit to be described later. This section also brings out clearly how small is the amount of the more recent or Upper Head accumulated since the glacial deposit was formed ; for here it extends quite a short distance from the very steep bank or inland cliff. Like the Lower Head, it is composed of coarse material only when close to this steep bank; the fragments becoming rapidly smaller as the lower slope is crossed. Indeed it is only when quite close to a steep bank that any appreciable quantity of Upper Head occurs and, further, the two divisions are recognisable when the glacial deposit, or its equivalent, can be traced beyond their junction in the direction of the steep slope. The total quantity of it in all the Islands cannot be large, although it has been accumulating in favourable localities ever since the close of the local glaciation referred to later on.

Local Details.

A good and easily accessible exposure of the Head occurs on the coast of St. Mary's in the low cliffs about Porthloo and east of Hugh Town. It here attains a considerable thickness, but varies much in coarseness of texture from point to point. This variation is clearly due to the fact that the steep rock-face behind the Head alternately recedes from and approaches the present low cliff-face; in the former case, the Head is finer, in the latter coarser. That there has been little movement of the component fragments parallel to the shore line is clearly shown by the Porthloo elvan or quartz-porphyry. Fragments of this occur in the immediately overlying Head, but certainly do not extend more than a few feet on either side of the outcrop of this dyke. On the other hand, that there has been a considerable forward and downward movement is shown by the fact (already noted) that in a few cases the well-rounded small boulders derived from the old beach can be detected some feet up in the Head; these small boulders must obviously have moved some yards seaward from the steep granite slope at the foot of which the beach was formed.

On the north face of St. Marys, where the interior cliffs escape the more powerful waves of the Atlantic, long and continuous slopes of Head still remain, and these, at times, are of considerable thickness. On the more exposed eastern and southern faces of the Island, only small patches are now preserved, and these lie in the more sheltered hollows, such as the Bay of Old Town and the larger and deeper bay on the south side of Hugh Town. In the latter the Head frequently assumes a terrace-like aspect and reproduces on its upper surface the contour of the old sloping platform on which it rests. The height of the upper part of these terrace-features brings out clearly the steepness of the slope of the shore-end of that platform. A precisely similar mode of occurrence and distribution of the Head has been noted along the shores of St. Martins, Tresco and Bryher, as well as along the margins of some of the smaller Islands; the upper surface of this material frequently assuming a terraced aspect.

Most of the islands are too small to have hollows in the interior of sufficient size to contain much Head; even where this material is clearly present, it is usually difficult to trace its boundaries. In the larger Island of St. Marys, however, and in St. Agnes some large patches have been mapped.

Iron-cement.

On examining the Head along the coast, especially where it has a rather broad outcrop, the highest portion is generally found to consist of very fine material. This deposit, though essentially of a sandy nature, has been called "clay" by the inhabitants of the islands, owing to its property of drying hard, in fact, of setting

like a cement, and it has been used in many old buildings to cement the walls in place of mortar.* This curious property of setting firmly when dry, raised the suspicion that it contained soluble silica which becomes insoluble when dried; in consequence, a specimen from a small excavation recently made on St. Agnes was tested by Mr. E. G. Radley, who found it to contain 3·8 per cent. of this material. On boiling in weak hydrochloric acid and precipitating with ammonia, a large amount of iron-oxide was seen to be present. Both the silica and oxide of iron evidently assist in causing this material to "set" when dry and bind it together with extraordinary tenacity. In consequence of this tenacity, the sea along the inner coasts will often eat away the underlying loose normal material of the Head, leaving a small projecting shelf of this "iron-cement." One notes with astonishment how small a thickness of this projecting material will support the weight of a man in perfect safety. This peculiarity of the fine, sandy material or Iron-cement that caps the normal Head is specially well shown on the south side of St. Martins, just about and above high-water mark; it is, however, fairly well seen in most occurrences along the inner coast.

In the interior of the islands, a thin cover of it occurs in many of the hollows intervening between the more or less bare patches of granite, but it is too thin and irregularly distributed to be mapped out. In St. Marys, a considerable amount of this fine material occurs in the old clay-pit (so-called on map) by the road-side about half a mile east-north-east of Hugh Town. The crest of the low hill close by is composed of bare granite, and the normal Head gradually sets in as the slope is descended; toward the foot of the slope, the Head is, in turn, capped with the fine, sandy deposit, or Iron-cement. This material is obviously a fine, somewhat micaceous, sand, and its junction with the normal Head is in places distinctly sharp, suggesting a somewhat different origin from the latter. The markedly sandy aspect and loose texture is possibly due to the cut face having been washed by rain, whereby the bulk of the soluble silicia and iron-oxide were extracted. In St. Agnes, where the alternation of patches of bare granite and intervening hollows is specially well shown, this fine material tends to accumulate in the lower portion of these hollows, and a small pit was recently opened in it a little above high-water mark, on Castella Down in the south west corner of the island. It was from this opening that the specimen was obtained which proved to contain the soluble silica and iron-oxide. A quarry, some 600 yards south-east of the lighthouse, has been opened in the Head, giving a complete section of the softer materials resting on the granite. At the top is some two feet of coarse granite sand, evidently

* This is probably the material mentioned by R. Heath, in his "Natural and Historical Account of the Islands of Scilly," 1750, p. 67. He says, "Their mortar is tempered with a sifted Earth, which they call *Ram*, and is said to make the strongest Cement for binding the Rock-stone together."

representing an Upper or Newer Head; this rests on a fairly even surface of the Iron-cement, which, in turn, rests on the normal Head, but with a very uneven base.

An exceptionally large area of this fine material fringes the fresh-water lakes of Tresco, and probably forms their bed. At first sight the shape of the ground suggests that the flat area should be classed as alluvium, but the component material is really the iron cement. This is shown by a large excavation made in it nearly 300 yards north-west of Tresco Abbey, on the south side of the Great Lake. Another but smaller opening in the same material may be seen on the south side of the fresh-water pool between the two bays on the west side of Bryher.

The origin of this curious deposit is by no means clear; it is distinctly micaceous and far finer in texture than the normal blown sand, as well as of a totally different colour and composition. It may have an eolian origin, however, and possibly represents the very fine material set free by the action of frost and blown directly from the bare granite surfaces; *i.e.*, without being first washed by the sea as the blown sand clearly has been. The idea of invoking the aid of frost in the production of this material is based on its substantial identity both in composition, mode of occurrence, and geological age, with the matrix of an undoubted glacial deposit, to be described next.

Glacial Deposit.*

The occurrence of Chalk-flints in the Scilly Isles has been noticed by several observers, among whom A. Smith † may be mentioned as giving the fullest account of them. N. Whitley also in a paper on "The Evidence of Glacial Action in Cornwall and Devon" refers to the "drift" in western Cornwall, remarking that, "These gravel beds, must however, have formerly extended far beyond the present coast line, as we find rocks of a distant origin and chalk-flints in the trail of drift which swept over the Scilly Isles." ‡

Till recently, however, their exact mode of occurrence and the manner in which the chalk-flints reached their present position was not understood. The tracing of their distribution soon made it clear that these stones really form part of a curious hard ferruginous sandy deposit closely resembling the Iron-cement already described as forming the top of the Head. Within this ferruginous material the flints associated with other stones occur in lenticular patches. The geological age of this curious deposit was first clearly defined in White Island, at the north-west end of St. Martins, and consequently it is advisable to give full details of the section seen there and then to refer the other exposures to this as a standard.

* This deposit was investigated in company with Mr. Reid.

† *Trans. Royal Geol. Soc. Cornwall*, vol. vii., p. 343.

‡ *Ibid.*, vol. x., pp. 133, 134.

White Island clearly once consisted of a small, curving ridge of granite flanked on both sides by softer, superficial deposits. But so rapidly have the Atlantic waves cut away the exterior portion of this ridge that all the superficial material and most of the granite slope have disappeared from it, so that we now see only an abrupt low cliff, above which the surface of the downward slope of the other side of the ridge at once commences. As a consequence of this shape, lines of weakness traversing the granite enable the sea to cut the rock open for an unusual distance, since it has to encounter a steadily diminishing thickness of resisting material. Along the most southerly of these lines of weakness in White Island, the Atlantic waves have cut a trench exposing the interior slope of the granite and the softer material lying on it. (*See* plate VI.)

Starting from the seaward end of the gully, the granite slope is first flanked by a small thickness of Head, which, though extending only a small distance, continues far enough just to overlap the taper edge of the Iron-cement bed containing the foreign stones. This bed steadily thickens along the side of the gully till it attains a maximum thickness of about three feet and is seen clearly reposing on the Main or Lower Head, toward the west or shore end of the section. The Head, in turn, overlaps the taper edge of a fragment of the old beach, and thus the succession of these superficial deposits is proved to be as follows in descending order :—

1. Upper or Recent Head.
2. Iron-cement bed or Glacial-deposit.
3. Main or Lower Head.
4. Old Beach.
5. Sloping surface of the Granite.

As already stated the Iron-cement bears the closest resemblance to the hard, sandy ferruginous material already described as occurring at the top of the main Head, but containing no foreign stones. When these stones are present, this material is rather more ferruginous, and probably even more coherent. The peculiar mode of occurrence of the stones is well shown in this section on White Island ; they tend to occur close together in lenticular patches.

At this locality the stones are not so numerous, or, perhaps more strictly speaking, show less diversity of origin than those met with at the eastern end of St. Martins; still, they show the typical features well enough. The most common pebbles are flint and a comparatively soft reddish-brown sandstone ; the latter are often flat on one face, suggesting their having been split open by frost ; in addition, many show faint striae and in a fair number of cases these striae are well marked. Several of these stones have been preserved in the boulder-collection at the Museum of Practical Geology.

The details of the former structure and shape of White Island have an important bearing on the extent of the glacial deposit, for on crossing the low bar or beach that connects White Island with St. Martins, these stones are met with in great abundance.

Their occurrence, in such a position, clearly shows that they are the remnant of the softer materials once flanking the eastern, or outer, side of the granite ridge of White Island in a precisely similar manner to that still left on the west. The finer portion of the matrix has been carried away entirely, but a large number of the harder stones have been thrown up by the waves, and now attest the former, far greater, extension of the glacial deposit. Proceeding eastward along the north shore of St. Martins it is impossible to tell if this deposit is present or not owing to the great amount of blown sand. But in St. Martin's Bay the Head emerges once more and is thirty feet thick, although its outcrop is so narrow that it cannot be shown on the map. No foreign pebbles were detected here, and it is not till the east side of the bay, north-east of the Higher Town, is reached, that they are again encountered. Here they are not numerous, and are lying loose and not embedded in the typical cement. Crossing the projecting headland into the next bay, however, two good sections of the glacial deposit are seen, one on each side of the bay.

In the more westerly section the glacial deposit rests on the Head and is less interesting than in that further east. Here the newer Head again caps the glacial deposit at the foot of the steep headland. (*See* Plate V.) In one place the former is eight feet thick and entirely composed of comparatively fine material, markedly ferruginous at its base. Below this is the glacial deposit, which here alone consists partly of tough clay. Indeed, at the centre of the outcrop, the Iron-cement and associated pebbles are embedded in the clay, the latter containing only a few isolated pebbles. One of these, however, was six inches in diameter, composed of pale basaltic material.

The western part of this small outcrop contains less clay, and the deposit almost resumes its normal aspect. It is soon seen, however, that the greatest variety of stones occurs here, and a number were collected, the more important features of which may be summarised as follows :—

The general aspect of the stones is such that a considerable portion of them must have been derived from an older deposit, as many of them are too well rounded to leave any doubt that they were derived from some gravel and not directly from the parent rock. They are divisible into the following groups :—

1. Chalk-flints.
1A. Greensand-chert.
2. Soft red-brown Sandstone.
3. Rocks from within an aureole of metamorphism surrounding one of the granites of the south-west of England.
4. Fragments of more or less hardened Killas.
5. Well-rounded pebbles of harder Sandstone.
6. Pale greenish sheared igneous material, suggesting fragments of dykes, but almost certainly not connected with the post-carboniferous granites.

1. The Flints, which are the most abundant of all the stones, are of two kinds : one unmistakable Chalk-flints, the other more difficult to determine, but many, when examined by Mr. Reid, proved to be Greensand chert. In many cases, however, the true nature of these flints could not be ascertained without the aid of a microscopic section. Both flint and chert are of somewhat peculiar character ; but they agree closely with, and are in the same state of preservation as those in the subangular Eocene river-gravels of Haldon, in Devonshire. Their occurrence suggests an easterly origin for these pebbles.

2. The soft red-brown Sandstone. The softness of this rock enables it to be easily scratched, while it is sufficiently hard to retain the scratches. This sandstone seems peculiarly liable to be split open along the old bedding planes when exposed to frost. The flat faces so often shown by the pebbles must have been produced after extraction from the tertiary deposit, and during their transport to their present position. A considerable variation in tint and size occurs in these pebbles, but they possess sufficient characters in common to enable them to be easily distinguished from the well-rounded fragments of the far harder sandstones which rarely, if ever, have flat faces.

Microscopic sections (4473-4474) show that the composition of the sandstone is so peculiar that it will be easily identified when a complete series of sections has been made of the rocks of the mainland. Fragments of quartz and felspar, clearly derived from a granite are common and the latter contains the parallel-arranged micas and zoisite so common in the very old granites. Sedimentary material is represented by chips of sandstone and shale showing a low phase of hornfels type of alteration, as well as by fragments of graphitic (?) phyllite and quartz-schist. Smaller igneous masses are represented by a rock having a felspar-lath groundmass. There is also present a clear almost glassy material, often full of brown dust, enveloping crystals of felspar. With such a composition, these pebbles will be identified in the first section made of the parent rock.

3. The Metamorphic Rocks. The pebbles of this group possess the peculiarity that, so far as structure and composition is concerned, they might have been derived from the aureole of metamorphism that must have existed to the north of the present Scilly Isles (and still exists under water), or from the margin of any of the other of the Cornish granite masses. The largest and most abundant of the metamorphic rocks consist of epidiorite, as might have been expected from the well-known hardness and durability of this material. Four sections have been made (4476-4479). The largest pebble is 4 inches in diameter and well foliated, being built up of yellowish and dark lenticles. The yellowish portion is composed of minute grains of sphene and felspar, the dominant constituent of the dark material being actinolite. Another specimen (4478) shows no foliation and is a typical example of paramorphic heat alteration, the original ophitic structure being well preserved. In 4479, the original structure was sub-ophitic and is partly preserved, the heat alteration here being less pronounced, while 4476 is a more schistose phase. All these rocks can be closely matched on the mainland in the aureoles of alteration surrounding the granite. Fragments of the dark mudstones showing the hornfels phase of metamorphism are not uncommon, while some fragments could be matched exactly at Cape Cornwall and Mousehole, on the mainland. Some of the hornfelsed rocks can be seen from their weathering to have been originally calcareous mudstones, and these, on a fractured face, have a somewhat cherty aspect. Identical rocks occur near the margin of the Bodmin Moor granite, and doubtless of the other masses. A curious small pebble with a somewhat cherty look proved on fracture to be a fine pale grit, the matrix of which has been rendered almost vitreous ; its origin is not yet known.

4. The fragments of Killas are often sufficiently hard to suggest a certain amount of thermometamorphism ; but a section examined by Dr. Flett id not show any clear evidence of this type of alteration. They vary considerably in composition ; some having been pure shales originally, others sandy shales. The latter show well the intense folding to which much of the Killas has been subjected.

The pebbles of harder sandstone vary in tint from green to grey. They are always well-rounded and apparently never split by frost. Some of the lighter coloured varieties may be fairly called quartzite.

5. Pebbles of a pale green igneous rock are fairly common at this locality, though comparativly rare elsewhere. From their fine-grained character they have probably been derived from dykes or small igneous masses, though probably not in any way connected with the Cornish granites.

The most easily identified of these is composed of a felspar-lath matrix in which are set abundant flakes of biotite and some very pale hornblende. The biotite is quite unlike that associated with the Cornish granites.

Four other specimens are all augite and felspar-lath rocks and mostly much decomposed. They vary in basicity and in minor points of structure, but one is characterised by the abundance of apatite needles. The rocks of this group will certainly be identified as the survey of the mainland progresses.

St. Martin's Head.—Ascending the steep slope towards St. Martin's Head, these stones are very rare; only a few irregular shaped flints were found after a careful search. The gradient is obviously too steep for well-rounded pebbles to rest on it; but on the flat top of the Beacon Hill these stones are extremely numerous, so much so as to raise a suspicion that they represent a remnant of an old tertiary deposit. This view is considerably strengthened by the fact that no ice scratchings were observed on the soft brown sandstone fragments, though the stones, as a whole, have the same composition and occur in much the same relative proportion as regard number. These foreign stones continue abundant for a distance of some 200 yards down the low slope south of the Beacon Hill. Still further south, they slowly decrease and at the end of another hundred yards they are either absent or very rare. They have not been met with on any other part of the higher ground of St. Martins, nor anywhere along the southern shore of the island.

West and South-West of White Island.—On the projecting north-west spur of St. Martins the deposit is represented simply by the foreign stones which rest on bare granite; while at the north-west point of Tean a small quantity of a brown cement is present as well. On the west and north shore of St. Helens, however, patches of the typical brown ferruginous cement are common and in this the foreign stones occur aggregated together to form the usual lenticular patches. In these fragments of altered Killas are rather more common than usual.

Tresco.—The distribution of these stones in Tresco is peculiarly interesting, as it was at the north end of this island that the first clue was obtained to their true mode of occurrence. In the bay (Gimble Porth) on the east side of the north end of the island, there is a long narrow strip of Head just about high-water mark. No foreign pebbles were found in any part of this deposit till quite the north end of the bay was reached, when they appeared quite suddenly. At first flints only were seen, the majority of which are small broken chips, but just before the end of the outcrop is reached, the normal assemblage of stones can be found. For a short distance further north the granite is bare of superficial

deposits; after which another outcrop of Head is reached, again this curious deposit with foreign stones rests on it. This patch of Head is small, and the granite further north has been washed practically clean by the powerful waves of the Atlantic. As so often occurs, the small patch of Head lies in a little hollow, and this hollow is continued up the hill inland with a comparatively gentle slope. Up the whole of this slope the pebbles in considerable numbers can be traced to the crest of the ridge (105 feet above sea-level) and down the corresponding slope on the opposite side of the headland. Moreover on the crest of the ridge they may be traced to some little distance to the south. On the opposite, or western, side, owing to the exposed nature of the coastline, practically no Head is met with north of Cromwell's Castle, but immediately south of this is a small and more protected bay in which another patch of Head has escaped denudation. On top of this patch the foreign stones are abundant in the northern portion only of the outcrop; further south they cease just as suddenly as they did on the opposite side of the island. If now the two points of cessation of this deposit on the two shore-lines be joined up their line of junction is seen to pass approximately along the southern limit of the stones on the crest of the hill.

Their distribution at the north end of Bryher is on exactly similar lines. A belt strewed with these stones crosses the northern end of the island from side to side, reaching a height at the summit of over 100 feet; but, as before, they cease somewhat abruptly to the south or rather, in this case, to the south-east, for the line marking their cessation is now turning round to the south.

On the Island of Samson erratics occur only at the south end, where they are associated with a small quantity of the ferruginous cement, but there has probably been much more of this deposit than is seen at present.

On Annet it has clearly fringed if not covered the whole island, excepting, of course, the small rising patch of bare granite at the north end. The present surface of this island is a mixture of fine soft material which has been completely dug over by puffins in order to make their nests, so that it is impossible to say what the first solid material is. The typical mode of occurrence of the stones is well shown along the shore line, and a distinct change in their nature can now be noted. Greensand-chert is specially abundant, while the characteristic soft red-brown sandstone is far less common. A white sandstone, hard, but not close enough in texture to be claimed as a quartzite, is often found.

The last place at which the pebbles occur in considerable numbers is on the north side of the first little bay south of the extreme west end of St. Agnes. Here, only traces of the cement are seen, but Greensand-Chert, Chalk-flints, and the white sandstone just referred to are fairly common. On the extreme north-west point of the island a few loose flints were noted, but unaccompanied

by any of the typical cement or any of the other stones. On no other part of St. Agnes has this deposit been met with and no trace was seen of it on St. Marys, though several localities where it was likely to occur were revisited after all the above recorded outcrops had been examined.*

That these stones have been brought into their present position by ice admits of little doubt. In the first place, the striations so often noted on the soft sandstone are almost certainly due to their being embedded in ice and scrubbed against some specially hard material, probably the quartz-grains of the granite of the Scilly Isles. Secondly, their curious distribution is such as to be unintelligible except by invoking some other means of transport than water. It is, however, the strange way in which these foreign stones sweep across the projecting headlands, rising more than 100 feet above sea-level, and yet ceasing abruptly only a few yards further south actually at sea-level, that seems to indicate the mode of transport. It is quite clear that they must have been carried by floe-ice, which at the projecting headlands broke to pieces, packed and was heaped up till a trail of it completely crossed the headlands. The fact that a deposit of it is found on the north and west sides of the group of islands as a whole suggests that either the wind, or powerful currents, from that quarter swept the ice against the land. It is most probable that the ice gathered along the shores in winter and was packed or heaped up by winds or tide. There is one peculiarly striking piece of evidence bearing on the mode of occurrence of the stones; they often occur in lenticular patches. The study of rocks in areas of great dynamic alteration shows that these solid bodies invariably break up into lenticles, or, more strictly, phacoids. In the lenticular mode of occurrence then of these foreign pebbles we have an actual record of the breaking up of the floe-ice, and of the heaping up on itself of the particular band of the latter in which the stones were specially abundant.

Since the above account of the Iron-cement and the Glacial-deposit was written, an opportunity has occurred of examining the "Limon" on the Brittany coast, north of Morlaix, St. Brieux, etc. This material was at once recognised as identical with the stoneless phase of the Iron-cement, and it has the same curious properties. The sides of railway cuttings made in it remain practically vertical, owing to its curious property of "setting" when dry. For the same reason it was formerly used to some extent in place of mortar in the walls.

The position of the Limon is the same as that of the Iron-cement. Where the succession is complete we have at the base patches of the old beach, above which comes the Head; while this in turn is succeeded by the Limon. As in the Scilly Isles, a small local

* *See*, however, A. Smith, *loc. cit.*, p. 344; Statham, *Geologist*, vol. ii., p. 14. (1859.)

deposit of Upper-Head rests on the Limon, only where the whole rests at the foot of a steep and rather high bank. So small and local is this latter material, that Dr. Barrois, who kindly accompanied me, prefers to call it "Wash," to distinguish it from the more extensive true Head, which possibly was accumulated under somewhat different conditions. It thus appears that over much of the Scilly Isles we have a thin equivalent of the stoneless Limon of Brittany; but on the northern and western parts of the islands, this deposit contains numerous well scratched stones and is essentially a glacial deposit.

As the Limon is generally held to be the equivalent of the Loess, the latter can now be gradually traced westward and northwards to the Scilly Isles, over part of which it is still Limon or Loess, while elsewhere it is a true Glacial deposit.

Alluvium.

Two patches only of Alluvium have been met with in the Scilly Isles, both of which occur on St. Marys and are shown on the map. Both appear to occupy the same position and have a similar origin, the nature of which is best shown by the larger patch a little east of Hugh Town. As already stated, bars of blown sand keep the spring-tide water out of this low-lying area, but before these were built up, the sea passed through this hollow and the greater part of it was filled with storm-beach boulders, before the fine material now seen at the surface was deposited. The latter rarely exceeds two feet in thickness and consists of a pale-grey or fine white clay, not unlike china clay in its tenacity. This fine clay was partly washed down from the marginal slopes and partly brought down by a small stream flowing through the valley to the north-east, during heavy rain, for there is no stream there during normal conditions at the present day. What underlies the storm-beach is not known; most probably bare granite, for the sea passing to and fro through this hollow would probably scour out any softer deposits; it would, however, be interesting to ascertain exactly what does occur here.

The somewhat smaller patch of Alluvium to the east has the same white clay over much of its surface as that already referred to; but what underlies much of this is not known. A very small stream—the only one known in the Scilly Isles—flows through the northern part of this flat ground and enters into a brackish or almost salt water pond, which communicates with the sea by means of an artificial drain. At high tide the water flows up this, and small fish pass through it to the little lake.

Blown Sand.

Considering the small size of the area above water, the amount of blown sand in the Scilly Isles is remarkable. It is exceptionally abundant on the Island of Tresco, where the characteristic features of its mode of occurrence and the phenomena to which it has given rise can be best studied. Along the whole of the southern and

most of the eastern shore of the island it forms a practically continuous ridge or bar. This bar commences about high-water mark and rises in some cases to about 35 feet, forming an admirable bank which keeps out the sea. Always steepest on the seaward face, it slopes more gradually on the reverse or inland side. In a few cases, the bar breaks up into two parts, an outer and a higher, and an inner and lower bar ; a small flat-bottomed hollow lies between the two, and in some cases is as low as high-water mark if not even slightly lower. Within the main bar on the southern part of Tresco is a depressed area containing a large fresh-water lake (the Great Pool), the surface of which is distinctly below high-water mark ; yet the sea water does not seem able to filter through, in spite of the porous nature of the protecting ridge of blown sand.

Little crags of bare granite here and there interrupt the continuity of the sand in this barrier, and there seems good reason to believe that these small projecting bosses first arrested the moving sand, and formed the original gathering points, from which the building up of the sand bars appears to have often started.

A more local, but high, ridge of blown sand occurs on the west side of the island, at New Grimsby, again acting as a bank and keeping out the sea from the north-west end of the Great Pool. It now becomes clear that, but for the blown sand ridges, the southern portion of the Island of Tresco would be separated at high-water from the northern ; in other words, the blown sand has had the effect of joining different granite patches or small islands together so as to form a continuous land-surface or one island. This latter effect is one of the characteristic features of the Scilly Isles, and the following examples of it may be quoted :—

Hugh Town, the port of St. Marys, is largely built on a broad bar of blown sand, which serves to unite the western granite mass with the long central one ; were the bar removed, these would be separate islands, at least at high water. A special interest attaches to this bar, as it is referred to in Borlase's account of the Scilly Isles, published in 1756. He notes that Hugh Town is liable to inundations from the sea ; but since that date the amount of blown sand has so increased that any serious inundation is now impossible.

In like manner the sea is prevented from inundating the alluvial area shown in the central part of St. Marys by one bar on the south side (at Old Town) and three on the north ; were these all removed as well as the one at Hugh Town, St. Marys Isle would be broken up into three moderate-sized islands and two or three small islets.

Samson again consists of two separate granite masses united by an unusually large mass of blown sand in the centre of the present island. Here, also, there is evidence of the large accumulation of this material in recent times, but far anterior to Borlase's visit. On the south side of the mass of blown sand about the centre of the island is an exceptionally large heap of limpet shells, clearly an old kitchen-midden. Large as it is, it has been almost buried under blown sand.

In St. Agnes also, the eastern part of the island is joined to the west by a sand bar, while the latter is united to a patch of granite in the north-west in a similar manner.

On the west side of Bryher detached masses of granite are joined to the main island by these bars, and similar phenomena may be seen on St. Martins, Tean and the Eastern Isles.

Specially fine examples of blown sand bars acting as walls to keep out the sea from low-lying land behind them, occur on the south side of St. Martins.

High Level Blown Sand.

In addition to the modes of occurrence already described, this blown sand occurs in three places at specially high levels. The first of these deposits is on the north-east side of Tresco, extending from Old Grimsby harbour to Grimble Porth, almost burying a low ridge of granite between these two small bays.

The second and third occurrences are, however, the most interesting, and these occur in St. Martins and St. Marys. That on St. Martins practically crosses the island at right-angles to the coast-line and about Middle Town forms a number of ridges or dunes trending roughly north and south. The sand forms a thin sheet at a height of 100 feet above sea-level on the flat top to the east of the houses. From this top it descends to the shore, thickening as it does so.

On St. Marys, a corresponding high mass of sand occurs on the most northerly point of the island. Just off this point is the Crow Bar, a great impediment to navigation at low water. This bar, formed of white sand identical with the blown sand, really represents an old blown sand ridge, now submerged, of larger dimensions than any at present existing, and the high level masses just referred to are the two ends of the bar.

It is this submerged bar that gives the clue to the large amount of blown sand present in the modern islands. *

It was clearly formed when the ground stood at a higher level when, in fact, the sea was more than 25 feet lower than at present. Now if the area lying between low-water mark and 25 feet below sea-level were raised, it is at once apparent that the land area would be doubled. If to this be added the area between the 25 and 50 feet submarine contours the further increase in dry land is comparatively small, except in the ground about Samson and St. Agnes.

From this it follows that the old bar was formed when there was a larger area above water to supply the component material. The sand of this old bar, like the present blown sand, is essentially composed of finely comminuted granite, the dominant constituents now being minute grains of quartz, and white felspar; the latter imparting the snow-white colour. The bulk of the

* See Statham, *Geologist*, vol. ii., p. 21.

blown sand was not, however, derived directly from the granite, but rather from the large sheets of Head, the former greater extent of which has already been pointed out. This granitic material is extremely soft and incoherent, and would easily be pounded to pieces and bleached by the action of the sea-waves. Thus, not only was the land higher when the Crow Bar was formed, but there was a far larger mass of soft material at hand to form the sand for building it.

As the land sank, the bar was partly spread out over the shallow sea within, and all the Head inland of it, which must have been of great extent, would equally come under the pulverising influence of the waves. This has finally resulted in the whole of the ground, except little projecting bosses of granite, above the submarine 25 foot contour being buried under a deposit of snow-white sea-sand. So shallow is this sea that, in stormy weather, the waves stir it up and it is carried to the shores at high water and left at low-tide. The winds blowing over the shore heap it up above high-water mark, and in this way the bars of blown sand have been formed. Their great size in proportion to the small area at present above sea-level is thus clearly due to the vast amount of this fine white granite sand only a few feet below the surface of the water at low-tide.

Not only do the waves throw up this material on the shore during storms, but, aided by powerful currents, they carry it out to sea through the deeper channels communicating with the open ocean. Approximately opposite the deeper channels, which communicate with the shallow area, are huge fans of the finest sand, so carried out, and their position is admirably shown by the trend of the 200 foot submarine contour, as the small accompanying map shows. (*See* Frontispiece, Plate I.)

Borlase referred to the several varieties of sand, much of it derived from the Moorstone (granite). "The finest sand, much coveted by the *Cornish* and others, for scouring brass, pewter, etc., and for drying up Writing-ink, is found only in *Porthmellyn* Cove on St. Mary's."

"In one part only of St. Mary's they have a shelly Sand, and those who carry on the best husbandry use this, and find their account in it."

He remarks that the soil generally is "what we call *Growan*; that is mixed with rough gravel (as the *Cornish* word implies), and therefore not apt to bake or grow stiff." *

The fertility of the growan soils is much greater in the low-lying situations of the Scilly Isles, than in the upland regions of Cornwall and Devon.†

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* "Observations on the Ancient and Present State of the Islands of Scilly," 1756, pp. 67, 68; see also Carne, *Trans. Geol. Soc. Cornwall*, vol. vii., p. 153.

† De la Beche, "Report on the Geology of Cornwall, etc.," pp. 475, 476; Statham, *Geologist*, vol. ii., p. 18.

CHAPTER IV.

RECENT MOVEMENTS IN THE SCILLY ISLES.

Attention has already been drawn to the existence between St. Marys and St. Martins of a submerged and denuded ridge of blown sand (the Crow Bar), which could only have been formed when the land stood at a distinctly higher level. Information has, however, gradually accumulated to show that in quite recent geological times even greater movements have occurred in the Scilly Isles.

In Borlase's account of these islands, published in 1756, evidence is given suggestive of recent subsidence, a special appeal being made to the walls well below high-water mark on the sands between Tresco and Bryher and Samson. This evidence, however, is not conclusive, as the walls would obviously be carried out some distance below high-water to prevent cattle creeping round them at low-tide. The fact, however, remains that it is difficult to recognise any trace of these walls in the position indicated by Borlase; they have either been thrown down and been buried under sand, or possibly a slight further subsidence has taken place. Clearly, this line of evidence is not now satisfactory, in the absence of a map showing how far seaward in his day the walls could be traced. In the same work, attention is also called to the paved causeway at Old Town, St. Marys, which he asserts could never have been made in such a position unless the ground were slightly higher above sea-level than at the time he wrote. The view here suggested is even more true at the present day, but even in this case it is quite possible that the blown sand bar which now renders the assistance of a causeway unnecessary did not then exist, and the latter was really built on the highest ground then existing. As already shown, the height of the soft material close to the sea-shore has not diminished, but in most cases considerably increased, owing to the piling up of the blown sand. In the north-west corner of St. Agnes is a small round pond, which formerly covered a larger area. In order to reclaim as much as possible of this, a drain was cut to carry off the water at low-tide; and at a depth of six feet, ferns were found which occurred in such a way as to suggest an old soil or land-surface. Unfortunately, the information obtained on this point, beyond the actual occurrence of the ferns, was too vague to be considered conclusive; though the impression that it was the old land-surface seems strong among those who actually saw the drain made. *

When, however, we turn to geological evidence on broader lines, more satisfactory conclusions can be arrived at. As already stated, there is found above the old beach in the Scilly Isles not merely

* See also Statham, *Geologist*, vol. ii., p. 13. (1859.)

the Head, as is the case on the adjacent Cornish coast, but in addition we have a true glacial deposit. The occurrence of this is of the utmost importance, for not only can the old beach be now seen to be identical with that on the Cornish coast, but it is obviously contemporaneous with that described by Messrs. Wright and Muff occurring on the south coast of Ireland. It is also identical with that occurring in the South Wales area, for in both instances the Head overlying the old beach is capped by a glacial deposit. Thus, then, the old beaches in the Scilly Isles, in Cornwall, in South Wales and in the South of Ireland are not only contemporaneous but, in addition, are older than part of the glacial deposits.

This beach now stands slightly above or slightly below modern sea-level, according to its position and the area in which it occurs; but it must have recently sunk at least 40 or 50 feet, for the evidence that there has recently been such a subsidence both in Cornwall and South Wales is conclusive.

In the case of the Cornish area, papers have been published, from time to time, in the Transactions of the Royal Geological Society of Cornwall, by Colenso, Carne, Henwood and others. All concur in showing that in following the stream-tin deposits under the estuaries, old land surfaces, apparently of Neolithic age, were met with at a depth of nearly 40 feet below the present sea-level. At a somewhat smaller depth human skulls have at times been found, clearly demonstrating the comparatively recent age of the deposit.

More recently, a paper was published by my colleague, Mr. Strahan, in which he described the occurrence at a depth of 30 feet of an old land-surface at the base of the new Barry Dock. Roots of trees were here found embedded in Boulder clay, clearly showing the downward movement of at least 30 feet in post-glacial times.* A broken polished flint implement of human workmanship, was found in one of the upper peat beds.

It is thus apparent that the following stages in the movements that have affected the Scilly Isles, can be clearly established:—

1. The formation of the Old Beach, at sea-level.
2. The Old Beach was raised at least 40 feet.
3. A comparatively recent subsidence has depressed the whole area of the South of Ireland, South Wales, Cornwall and the Scilly Isles at least 40 feet, for it has brought the Old Beach back again to sea-level; indeed in the case of the Scilly Isles, almost to low-water mark.

The comparatively modern date of the downward movement along these coasts is clear enough; but the length of the preceding period that elapsed between the formation of the old beach and its

*For further details of these movements, see *Trans. Royal Geol. Soc. Cornwall*, vol. iv. (1832), in which several papers occur bearing on this point. Also A. Strahan, *Quart. Journ. Geol. Soc.*, vol. lii. p. 474 (1896), (Account of the Barry Docks).

maximum elevation is more difficult to decide. Making all allowances for the more rapid formation of the Head anterior to the deposition of the Iron-cement, it is still clear that this so enormously exceeds in bulk the Head formed in post-glacial times, that a much longer period must have apparently been required for the formation of the older portion of this material.

In view of the clear evidence of movement given above, the question naturally arises: are the coasts of this portion of the country still sinking? There is no clear evidence of this; the only fact suggestive of it being the occurrence of the fine Iron cement around the margins of the Great Pool, on Tresco. The colour of this material is conclusive that it cannot have been under the sea, for in the latter case it would have inevitably been bleached, like the almost snow-white granite sand. The edges of the pool are below high-water mark and obviously the ground has here sunk since the blown sand bars were built up, which so effectually keep out the sea-water. Unfortunately the exact date of this sinking cannot, with our present knowledge, be determined; and to prove a very small sinking of the sea, in view of the constantly disturbed nature of its surface, is by no means easy.

One point has been established in the clearest manner: the area above water in the Scilly Isles has not diminished in recent times, but has distinctly increased; and this increase is due to the constant washing up of the fine sand from the shallow sea-floor to the foreshore. From this position, in dry weather, it is blown further inland and so constantly continues the process of connecting one isolated island or islet with another and sheltering the low-lying ground behind from the inroads of the sea. (*See* Plate VII.)

APPENDIX.

Bibliography.

List of Principal Works on the Geology of the District.

1750.

Heath, R. A Natural and Historical Account of the Islands of Scilly, and a General Account of Cornwall. 8vo. London.

1754.

Borlase, Rev. W. An Account of the great Alterations which the Islands of Sylley have undergone since the Time of the Ancients, who mention them, as to their Number, Extent, and Position. *Phil. Trans.*, vol. xlvii., p. 55.

1756.

—— Observations on the Ancient and Present State of Islands of Scilly. 4to. Oxon.

1758.

—— The Natural History of Cornwall. Fol. Oxon.

1818.

Majendie, A. Notes on the Coast West of Penzance, and on the Structure of the Scilly Islands. *Trans. Roy. Geol. Soc. Cornwall*, vol. i., p. 27.

1839.

De la Beche [Sir] H. T. Report on the Geology of Cornwall, Devon and West Somerset. (*Geol. Survey.*) 8vo. London.

1850.

Carne, Joseph. On the Geology of the Islands of Scilly. *Trans. Roy. Geol. Soc. Cornwall*, vol. vii., pp. 140–154.

1858.

Smith, A. On the Chalk Flints and Green sand Fragments, found on the Castle Down of Tresco, one of the Islands of Scilly. *Trans. Roy. Geol. Soc. Cornwall*, vol. vii., p. 343.

1859.

Statham, Rev. F. T. On the Geology of the Scilly Isles. (*Brit. Assoc.*) *Geologist*, vol. ii., pp. 12–27.

1870.

Richardson, C. T. On a Visit to the Scilly Isles. *Proc. Geol. Assoc.*, vol. ii., pp. 36, 37. 1879.

Scott, L. and H. Rivington. The Agriculture of the Scilly Isles. *Journ. Roy. Agric. Soc.*, ser. 2, vol. vi., pp. 374–392.

Ussher, W. A. E. Historical Geology of Cornwall. *Geol. Mag.*, pp. 27–36.

1884.

Hunt, Robert. British Mining. 8vo. London, [Scilly Isles, pp. 9-15

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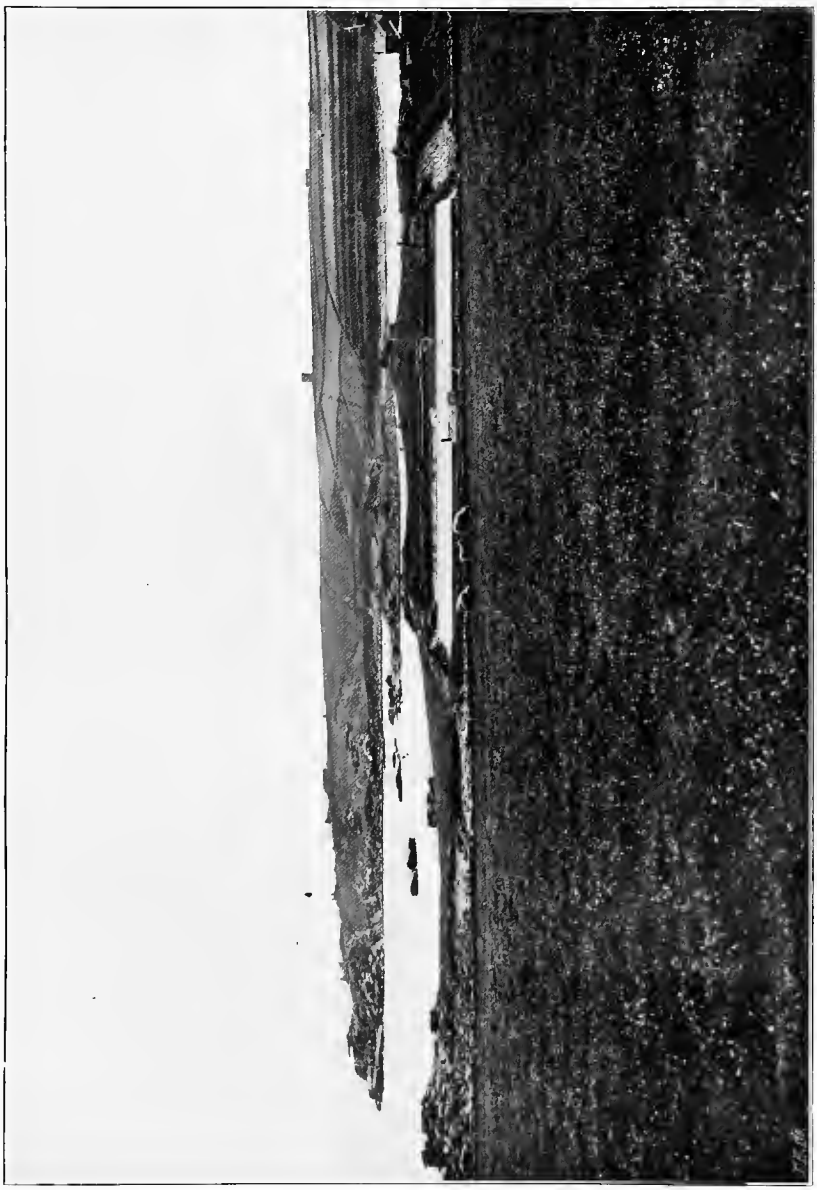
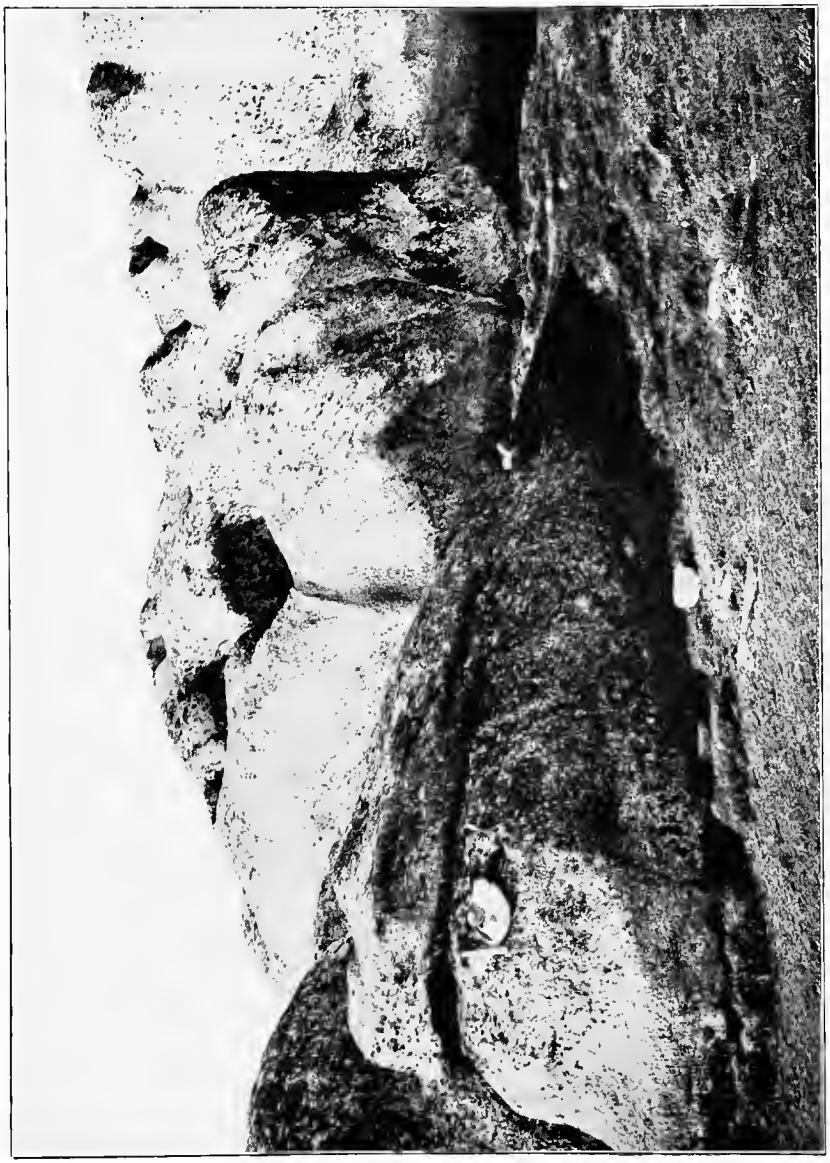
PLATE II.—View taken a little south-east of Old Town, St. Marys, looking west. Shows the north and south trending boundaries of land and water, and of inland features. Also the table-land of the central granite mass of St. Marys.



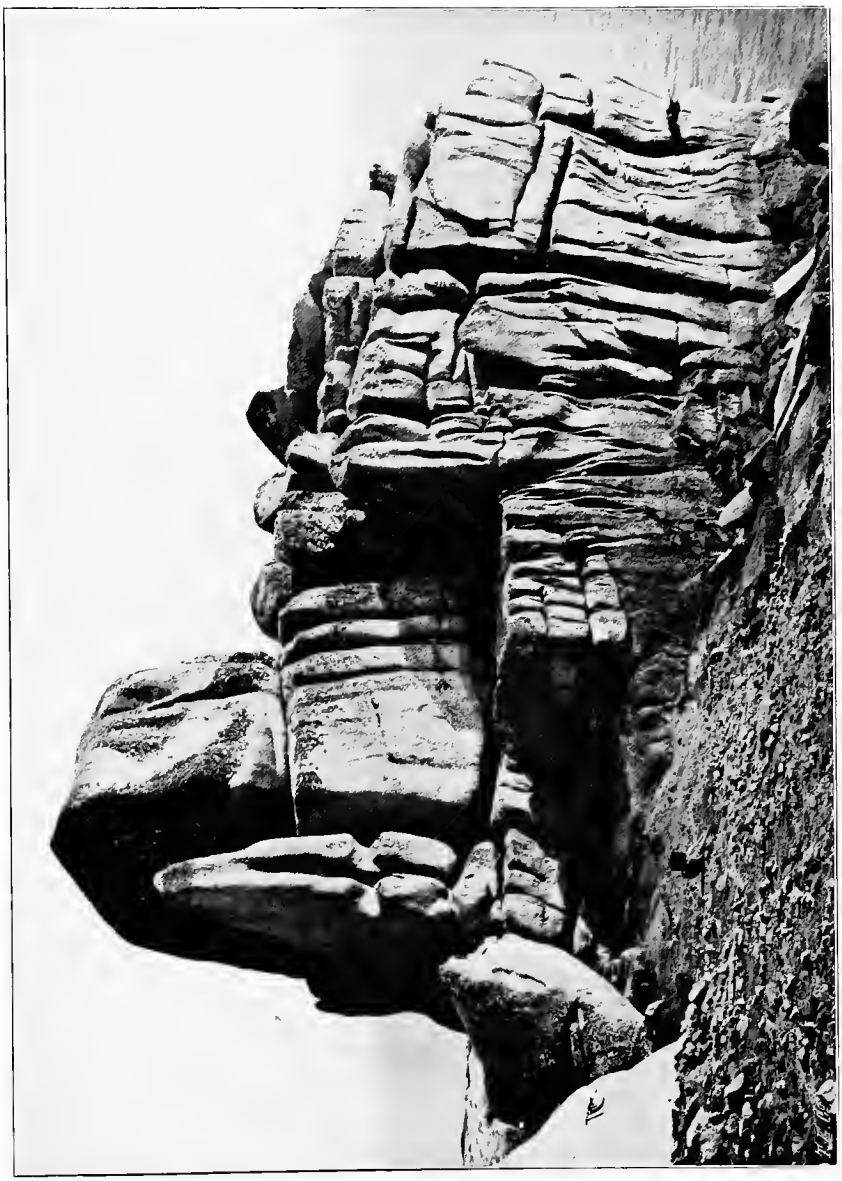
View taken near Old Town, St. Marys.

PLATE III.—Kettle and Pans, near Peninnis Head, St. Marys. To show weathering of granite. These hollows were claimed by Borlase as the sacrificial altars of the Druids.



KETTLE AND PANS, NEAR PENINNIS HEAD.

PLATE IV.—West side of Peninnis Head. Shows vertical fluting of the granite, and in addition the horizontal weathering so characteristic of the "Carns" or "Tors" of the Mainland.



West side of Peninnis Head.

PLATE V.—Bread and Cheese Cove, west of St. Martin's Head. The Glacial deposit and the Head are seen just above the shore line at the foot of the bare granite slope on left of photograph.

BREAD AND CHEESE COVE, WEST OF ST. MARTIN'S HEAD.

PLATE VI.—Gully at south end of White Island, St. Martins. The gully has been eroded along a "Greisen-line" in the granite, and the sea is to the left, or on the opposite side of the ridge forming the sky-line. On top of the granite, to the right, and continuing across nearly two-thirds of the photograph is a small band of rounded pebbles, forming the "Old Beach." The angular material above is the main Head and on this is the fine Iron-cement, containing patches of pebbles, some glacially straited. One of these patches is shown near the right edge of the photograph.

GULLY AT THE SOUTH END OF WHITE ISLAND, ST. MARTINS.

PLATE VII.—South-west end of St. Martins. Showing bars of Blown-sand, keeping out the sea from the low-lying land behind. This ground is devoted to flower-culture, and a number of high hedges of *Escallonia* are shown, grown to break the force of the wind.

South-west end of St. Martins.

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